Voyager Bulletin

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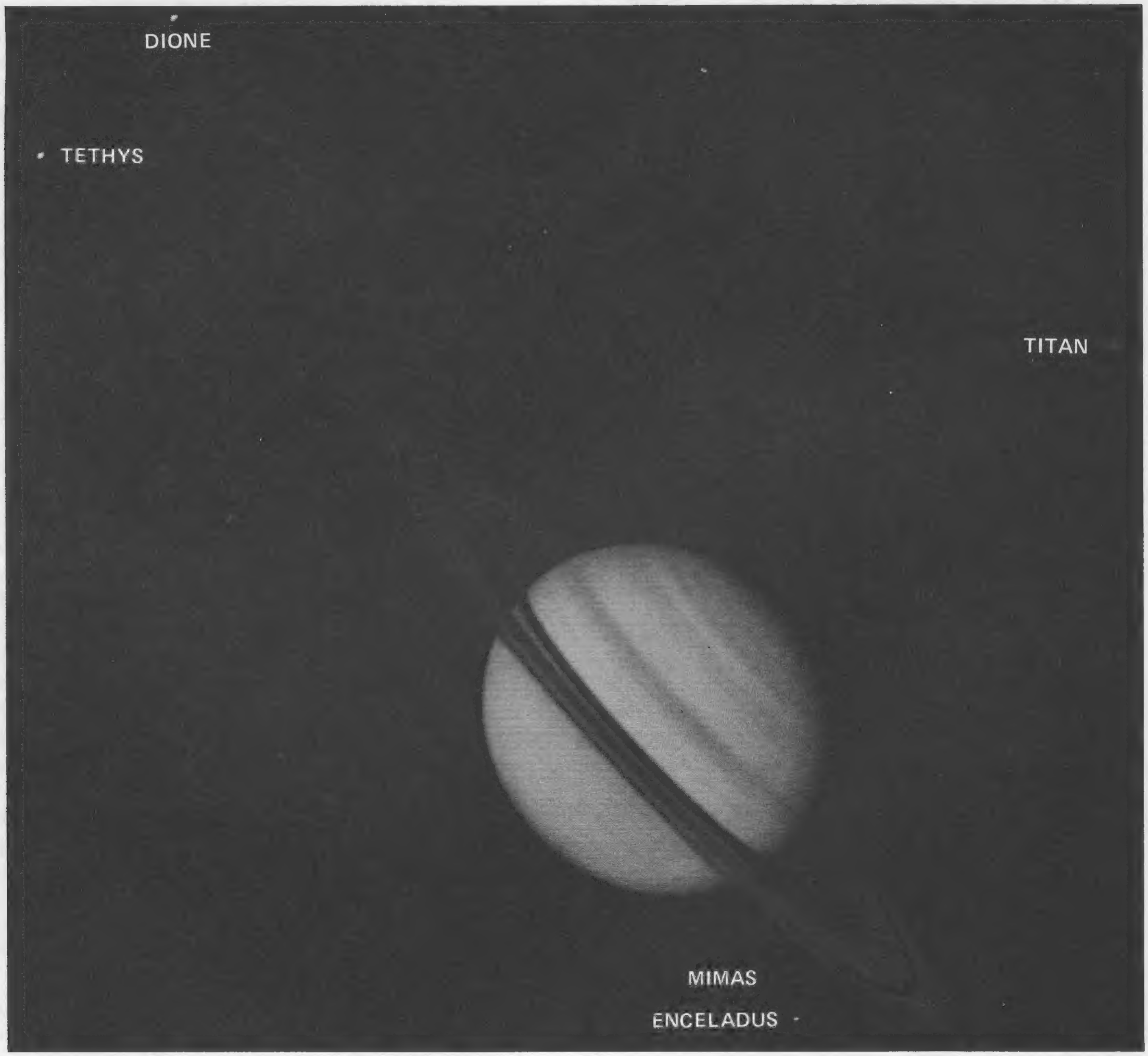

Voyager 1
September 17, 1980
Range to Saturn: 76 million kilometers

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UPDATE

Voyager 1 will perform a planned trajectory correction maneuver on October 10. The thrusters will fire briefly to accelerate the spacecraft about 2 meters per second and to change its course slightly. Without this approximately 13.7-minute burn, the spacecraft would be on a collision course with Titan, Saturn's largest satellite. Voyager 1 is scheduled to swoop about 2500 miles above Titan's clouds on November 11. A final course correction is scheduled for November 7 if needed to "fine tune" the flight path.

Only two more weeks remain in Voyager 1's "Observatory" phase consisting of routine, cyclical observations of the Saturn system. Picture resolution is now about 1640 kilometers, compared to about 5000 kilometers for the best Saturn photograph ever obtained from earth. On October 24, the cameras will begin four-picture (2 X 2) mosaics of the planet and rings.

As the spacecraft nears the Saturn system, a search for new satellites will continue. Two small satellites are thought to orbit at the same distance as Dione, one trailing several degrees behind and the other leading several degrees ahead. Sets of two (i.e., 1 X 2 mosaics) long-exposures through the clear filter will be used to try to capture images of these satellites and the rings. The pictures will be used primarily to calculate the orbits more precisely and to provide coverage of the rings which are beginning to overflow the narrow-angle camera's field of view as Voyager 1 nears the planet.

SATURN

> "There is not perhaps another object in the heavens that presents us with such a variety of extraordinary phenomena as the planet Saturn: a magnificent globe . . ."
>
> –Sir William Herschel
> in **Singular Figure of Saturn** (1805)

Herschel was among the many through the ages who have been fascinated by the sixth planet, its nest of rings, and its covey of satellites. Over 2600 years of observations have yielded volumes of knowledge on the Saturn system, but this steady flow of learning is about to accelerate tremendously as Voyager 1 homes in.

One of the solar system's four outer planets known as the "gas giants" (along with Jupiter, Uranus, and Neptune), Saturn is unique in its extremely cold atmosphere with high-speed winds; its nested set of rings; and its mismatched set of moons.

These outer planets are huge accumulations of helium and hydrogen with small rocky cores. Saturn's overall density is about seven-tenths that of water – which means that the planet could float if there were a cosmic ocean. An enormous balloon of hydrogen and helium, Saturn could hold about 770 earths – but is only 95 times heavier than earth.

Current models of Saturn's interior suppose a small, heavy, rocky core which may be twice earth's size but 15 to 20 times heavier due to large concentrations of rock and iron. Pioneer 11 measured the core radius at 13,800 kilometers (8,575 miles). Enveloping the core is a form of electrically conductive liquid metallic hydrogen not found on earth because of the great temperatures and pressure required to produce it. Beyond this is a shell of hydrogen and helium to the cloudtops, with heavier helium sinking through to the interior hydrogen.

Several other gases are known to exist at Saturn, including heavy hydrogen (deuterium), methane, ethane, and phosphine. Helium has not been confirmed, but its existence is inferred from other factors.

Saturn is indeed an oblate spheroid, with flattened poles and a bulging equator. About 5800 kilometers (3600 miles) difference has been measured between the polar and equatorial radii. The generally accepted equatorial radius is 60,300 kilometers (37,500 miles).

Both Jupiter and Saturn radiate about twice the amount of energy they receive from sunlight, despite their great distances from the sun. Saturn should have cooled long ago, as it receives 100 times less sunlight than earth. Heat must therefore be generated in some other way – perhaps by interaction between the hydrogen and helium.

Even with its own heat source, Saturn is still colder than Jupiter, and material freezes at greater cloud depths. Ammonia, for example, freezes and forms clouds at a depth of two to three atmospheres on Saturn, compared to one atmosphere at Jupiter (an atmosphere is a unit of pressure corresponding to about 14.7 pounds per square inch at sea level on earth).

A considerable quantity of atmospheric dust is believed to exist, also. A high altitude haze, probably of ammonia, obscures the clouds. A belt/zone system exists similar to Jupiter's.

Visual measurements of Saturn's rotation rate give a figure of 10 hours 14 minutes for near-equatorial regions, while measurements of the pattern of Saturn's radio signals give a rate of 10 hours 39 minutes 24 seconds, more nearly akin to visual measurements at high latitudes. Precise measurement of the rate at different latitudes is important for targeting Voyager's various instruments and correlating their data. The difference in wind velocities between Saturn's equatorial and temperate zones indicates equatorial wind velocities of 1400 kilometers (900 miles) per hour – nearly twice the speed of Jupiter's winds. These wind speeds may account for the lack of long-lived atmospheric features.

Saturn's rotation axis is inclined about 26.75 degrees from earth's orbital plane, accounting for the seeming tilt of the rings which rotate about Saturn's equatorial region. The planet's orbit is not strictly elliptical, but is affected by other planets, especially Jupiter. Wandering between 9 and 10 AU from the sun (an AU is earth's distance from the sun), Saturn makes a full trip in about 29.5 years.

While each of Voyager's instruments operates independently, gathering specific data, analysis of Saturn is interdependent. The combined data will comprise our most comprehensive picture of the Saturn system.

At the planet, infrared spectroscopy will give information on atmospheric gas composition and abundance, clouds, hazes, temperatures, circulation, and heat balance. Ultraviolet spectroscopy will study how sunlight is absorbed and scattered in the atmosphere, to learn more about the atmospheric composition and structure. Photographs will afford a study of global wind systems and the atmospheric structure. Radio signals passing through the atmosphere will tell about the vertical structure of the atmosphere, ionosphere, clouds, and turbulence.